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Final Scientific Report

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"A High-Speed Digital Camera System for Flow Visualization"

AFOSR-85-0041

Principal Investigator: Professor C. T. Bowman
Department of Mechanical Engineering
Stanford University

July 1986

Final Scientific Report

SUMMARY

This grant enabled the purchase of a Spin Physics S-2000 high-speed digital camera system for use on DoD-sponsored research on turbulent reacting flows. The camera system has been employed to obtain high-speed schlieren images of pulsed jet flames and of the flow field in a dump plane combustor. In addition, the camera system has been coupled to a pulsed copper vapor laser to obtain planar images of Mie scattering from small refractory seed particles in reacting flows. These particle images can be used to obtain instantaneous planar images of the velocity field.

SYSTEM DESCRIPTION

The Spin Physics SP-2000 Digital Camera System comprises a microprocessor-controlled fast-readout MOS solid-state sensor array (192 x 240 pixels) coupled to an ultra high-density magnetic tape data recorder. Important operating characteristics include: (1) high-framing rate (the system can record up to 12,000 images per second); (2) extended recording times (the system can store 540,000 sequential images, corresponding to a recording time of 45 seconds at 12,000 images per second); (3) fast data display (the system allows instantaneous slow motion tape review of the data after recording); (4) provision for direct computer interfacing (recorded images can be directly transferred to external computers for image processing); (5) user friendly (the system is controlled from a built-in console); and, (6) external triggering capability (the camera can be used to trigger an external light source, such as a pulsed laser, for stroboscopic imaging).

DESCRIPTION OF RESEARCH

The Spin Physics camera system has been used to obtain time-resolved flow field images in several turbulent reacting flows. Conventional schlieren images of a pulsed jet flame and of the flow field in a dump plane combustor have been recorded. In addition, the camera system has been coupled to a pulsed copper vapor laser to obtain stroboscopic images

of Mie scattering from small refractory seed particles in the pulsed jet flame. An example of these images is shown in Figure 1. The complex nature of this flow is evident in the image. In addition, the Mie scattering technique is being developed to obtain instantaneous planar velocity images in reacting flows. In this application, multiple pulses from the copper vapor laser are recorded on a single image, and the velocity field is constructed from particle streaks.

SYSTEM LOCATION

The Spin Physics Camera System is located in the High Temperature Gasdynamics laboratory on the Stanford campus. However, since the system is portable it has been used on research programs in other laboratories on campus, notably for flow visualization in the Department of Aeronautical Engineering.

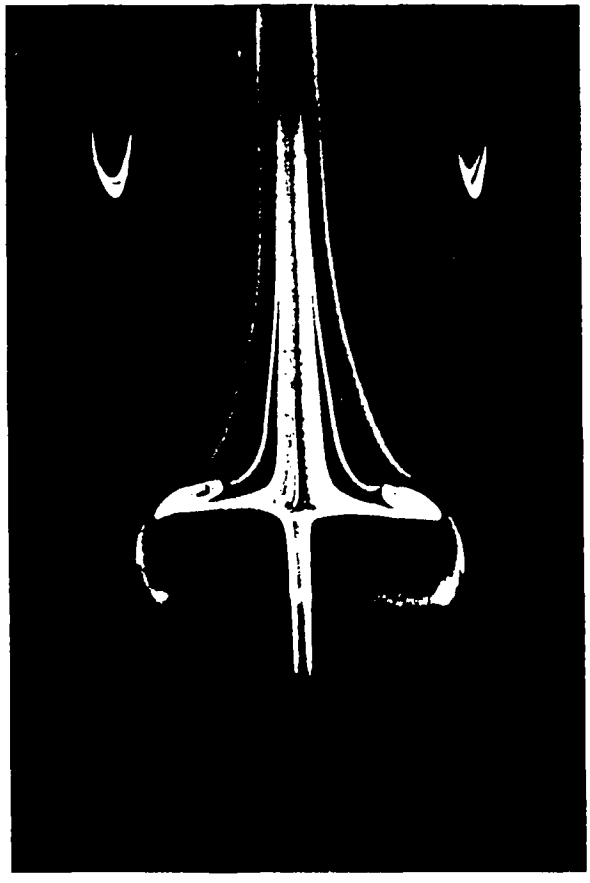

Figure 1. Image of flame radiation and Mie scattering from TiO_2 seed particles in a pulsed laminar non-premixed methane-air flame.